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INDIA

सत्यमेव जयते

GOVERNMENT OF INDIA
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Ministry of Commerce and Industry
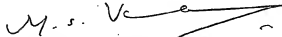### Department of Industrial Policy and Promotion

It is hereby certified that annexed here to is a true copy of **Application, Provisional Specification & Abstract** of the patent application as filed and detailed below:-

Date of application : 15-12-2003

Application No : 1016/CHE/2003

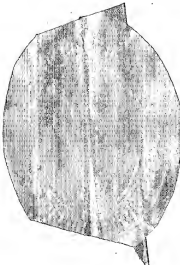Applicants : **M/s. Matrixview Pte Ltd, 9, Shenton Way #05-02, Singapore 068813.**

In witness there of
I have here unto set my hand

Dated this the 18th day of March 2005
27th day of Phalguna, 1926(Saka)

By Authority of
THE CONTROLLER GENERAL OF PATENTS,
DESIGNS AND TRADE MARKS.

(M.S.VENKATARAMAN)
ASSISTANT CONTROLLER OF PATENTS & DESIGNS

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Chennai – 600 018. India.

CBR : 7135

1016/CHE/03

FORM 1

The Patents Act 1970
(39 of 1970)

APPLICATION FOR GRANT OF A PATENT
(See sec.5 (2), 7, 54 and 135 and Rule 33A)

011810

15 DEC 2003

OFFICE (BR)

Matrixview Pte Ltd
9 Shenton Way #05-02
Singapore 068813
Tel: (65) 6336 2777

1016/CHE/2003

15·12·2003

1.   Hereby declare –
      (a)   That we are in possession of an invention titled
             "NOVEL ALGORITHM FOR DATA DECOMPRESSION"

      (b)   That the Provisional Specification relating to this invention is filed
             with this application.

      (c)   That there is no lawful ground of objection to the grant of a patent to
             us.

2.   Further declare that the inventor for the said invention is,

             Arvind Thiagarajan
             H 24/6, Valgai Street, Besant Nagar
             Chennai 600090. Nationality - Indian

3.   We, claim the priority from the application(s) field in convention countries,
      particulars of which are as follows:-

             Not applicable

4.   We state that the said invention is an improvement in or modification of the
      invention, the particulars of which are as follows and of which we are the
      applicant/patentee:

             Not applicable

5.   We state that the application is divided out of our application, the particulars
      of which are given below and pray that is application deemed to have been
      filed on _____ under section 16 of the act.

             Not applicable

6. That we are the assignee of the true and first inventor.

    Not applicable

7. That our address for service in India is as follows:

    Matrix View Technologies (India) Private Limited
    No.69, Mahalakshmi Koil Sreet
    Kalakshetra Colony, Besant Nagar
    Chennai 600090. TAMILNADU. INDIA.

8. Following declaration was given by the inventor or applicant in the convention country declare that the applicant herein is our assignee or legal representative

    Not applicable

9. That to the best of my knowledge, information and belief the facts and matters stated herein the correct and that there is no lawful ground of objection to the grant of patent to us on this application.
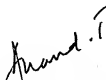
                                                    Mr. Arvind Thiagarajan
                                                          (Inventor)

10. Following are the attachment with the application:

    a)   Provisional specification (3 copies)
    b)   Fee of Rs.

    I request that a patent may be granted to us for the said invention

    Dated at Chennai on this 11th day of December, 2003

                                                    Mr. Anand Thyagarajan
                                                    (Authorized Signatory)

    To

    The Controller of Patents
    The Patent Office
    At Chennai

The Patents Act, 1970

Provisional Specification

Section 10

"NOVEL ALGORITHM FOR DATA DECOMPRESSION"

Applicant:

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TAMILNADU. INDIA.**

The following Provisional Specification describes the nature of the invention and the manner in which it is to be performed.

Field of Invention

The Present Invention relates to the decompression of compressed images or other highly correlated data streams

Background of Invention

The role of data and image compression assumes significant importance as the world makes a paradigm shift from analog to digital systems. Data compression, which was impossible due to the inherent disadvantages of the analog systems, has become a feasible reality with digital systems. The computational overheads and the complexity posed the most serious threat to the development data compression. With the advent of high-speed digital processors with MIPS capability most of these problems have been overcome.

Image compression has many practical applications, which are driven by the fact that image data is a highly correlated data stream. Image compression can be either lossy or lossless depending on the criticality and nature of the application. The human eye is more sensitive to changes in luminance than to changes in color. Hence for applications that are not critical in nature i.e. in cases where the quality of the compressed data is not an important factor for further processing lossy compression can be employed. The portions of the image data that do not produce a perceptible visual difference are removed resulting in excellent compression ratios. There are applications where image distortion is totally unacceptable, which require only lossless compression, where portions of image cannot be removed no matter how inconsequential the data is, resulting in very low compression ratios. An ideal solution to this problem will be a lossless compression technique that produces significant

compression ratios, which is exactly the motivation behind this unique and novel invention.

Data Compression Principles

All the data compression techniques are based on the fundamental principle of Shannon's Information theory, which says that there is a limit to the number of bits required to code a unique symbol, called entropy, given by

$$H = - p_i \log_2 p_i$$

Where p_i is the probability of occurrence of the symbol. The implication of this equation is that if a symbol occurs many times, i.e. the frequency of occurrence is high then this symbol contributes to redundancy and is hence given lesser priority when compared to a symbol whose frequency of occurrence is much lesser. This forms the basis for all the entropy coding or source coding schemes. The idea is to give a shorter codeword to more probable events i.e. the more frequently the symbol occurs, the SHORTER it's codeword is. Image data follows a Palladian distribution, which means that the occurrence of each symbol is equiprobable. Hence all the symbols require almost the same number of bits resulting in very low compression ratios. To achieve high compression ratios we should transform the image data stream in a manner where the even probability distribution in the original image is transformed to a probability distribution that has a few symbols having a high frequency of occurrence the other symbols a relatively low frequency of occurrence, resulting in a significant reduction in the bits per symbol, thereby enhancing the compression ratios.

Some of the popular entropy encoders are Run Length Encoder, Huffman, Shannon Fano, Limpel – Ziv, Arithmetic Encoder etc. All the encoding techniques

with the exception of the arithmetic encoder allot a minimum of atleast one bit per symbol. The arithmetic encoder, whose unique algorithm generates a real number for a given sequence of symbols, can theoretically achieve bit rates of less than one bit per symbol.

Current Compression Technologies

Image compression technologies can be broadly classified as either Lossy or lossless. An image compression technology can be classified as Lossy or Lossless depending on whether the subsequent decompression of the compressed data produces an exact pixel-to-pixel replica of the original data or not.

We can logically infer from the above that any efficient compression technique requires a transformation also known as pre – coding, which in turn aids in increasing the efficiency of the second step, the entropy coder. At this stage it must be emphasized that if the entropy coder has to produce good compression ratios then the pre – coding should transform the data into a form suitable for the entropy code. If the transformation is not efficient enough then the entropy coder is rendered redundant. Hence it can be logically concluded that the pre- coding or the transformation is the most important stage of any image compression algorithm

The most popular pre – coding transformation used in image compression is the Discrete Cosine Transform (DCT). This transformation gives the frequency and extent of data change inside the image. Another important property of any transformation is that it should be reversible too, so that the reverse process

can be applied at the decompression stage to obtain the original image. This transformation is extensively used in the JPEG algorithms and its variants

As indicated above DCT is a reversible transform whose forward transform is given as

$$DCT(i,j) = \frac{1}{\sqrt{2N}} C(i)C(j) \sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right]$$

where $C(x) = \frac{1}{\sqrt{2}}$ if $x = 0$,   else 1 if $x > 0$.

DCT (i, j) = C (i). C (j). Σ Σ f (x, y).......

The above-mentioned technique poses the following problems

The complexity of the equation in terms of the number of multiplications and additions, The most straightforward way to implement the DCT is to use the defining Equation In the 2D case, with arrays of dimensions $N \times N$, the number of multiplications is on the order of $2N^3$ using a separable approach of computing 1D row and column DCT's. Specifically, for an 8 × 8 pixel array, which is used in the JPEG family we have 1024 multiplications and 896 additions. In spite of the tremendous improvement made in terms of reducing the number of computations, the reduction has not been significant enough to reduce the tremendous overhead it places on the hardware that implements the algorithm.

Even though the image data is an integer their multiplication to cosine terms in the formula produces fractional numbers or real numbers because cosine values are fractional in nature until and unless the integers are in multiples of Pi, which might not be the case. Since fractional numbers need infinite precision to store them exactly as they might produce errors in the

reverse process resulting in losses, which mean that they are no longer pixel to pixel lossless.

Another popular transformation used is called the wavelet transform, which is used in the latest image compression techniques like JPEG2000. This uses a mother wavelet to decompose the image data into frequency sub - bands, which in turn increases the redundancy in most of the sub – bands hence improving compression ratios. Used in their original form the mother wavelets do not give integer-to-integer transformation but when used after a process called lifting they become integer-to-integer transforms thereby making the entire process lossless.

Color Transformations also offer an interesting prospect to compression. Commonly used color space is RGB where every pixel is quantized by using a combination of Red Green and Blue (Primary Colors) values. This format is ideally suited for designers but not so ideal for a compression algorithm. As indicated above the human eye is more sensitive to luminance than to color. Hence Chrominance Luminance and Value format offers an interesting perspective to compression.

Principle

It is essential for the   decompressed image to be exactly the same as the original image. Once information is discarded, it can never be retrieved, so when data that has been compressed in this fashion is decompressed, the result is only an approximate.

The Wavelet compression algorithm filters the original image into high and low-frequency sub-bands, that progressively lead to the floating point

values that create a loss during the reconstruction process. Also, for a loss less wavelet compression, more number of coefficients is required for the reconstruction, which leads to a low compression ratio.

Also compression algorithms like JPEG LS involve prediction that will hamper the image reconstruction. **Present Invention algorithm does not employ approximations of any sorts that guarantee a perfect reconstruction of the lossless compressed image.**

This type of algorithm is absolutely a boon in the fields of digital image decompression. The Present Invention codification technique is ideally suited for highly correlated data and digital images, as there is high accuracy requisition and that certain errors and distortions can affect the image quality.

Present Invention, maintains full fidelity of the original digital data during the process of compression and decompression in a perfectly loss less manner rendering a high compression ratio as there is no prediction or quantization or approximation in the process.

Present Invention is a perfectly reversible technique of compression. The logical transform ensures a loss less and on the fly decompression. The original data/image is retrieved perfectly loss less. As the reversion algorithm of Present Invention is also an integer-to-integer transformation, loss of data is eliminated. The retrieved image is visually and mathematically identical to the original image data.

Description

Present Invention decompression first constitutes the decoding process. A Run length decoder follows the arithmetic decoding. The decoded data is then passed for reverse transformation and data rearrangement (refer fig.1) Present Invention's reverse transformation primarily has four variants namely

1.   Horizontal Variant

2.   Vertical Variant

3.   Predict Variant

4.   Multidimensional Variant

Horizontal, Vertical and Predict Variants can also be classified as 1 – Dimensional category and Multidimensional can be classified 2 – Dimensional category. The data re – arranging stage of comprises of the following steps

1.   Reversible – Sort process

2.   Last to First re–arrangement

Applications of the Present Invention

Present Invention can be used in a wide gamut of applications ranging from Medical Imaging to Digital Entertainment to Document management. Each of these verticals requires Repetition Coded Compression to be implemented in its own unique way to deliver a robust and powerful end product.

Present Invention could be deployed in the following forms for commercialization.

1. Chip – (ASIC7, FPGA etc.)

2. DSP, Embedded Systems

3. Standalone Hardware boxes

4. Licensable Software (as DLL's OCX etc.)

5. Software deliverables

Thus, the above mentioned account describes the invention in detail. It is intended that the foregoing description is only illustrative of the present invention and it is not intended that this unique invention be limited or restricted thereto.

Many specific embodiments of this novel invention will be apparent to one, skilled in the art from the foregoing disclosure. The scope of the invention should be determined not only with reference to the above description but to all other additions, substitutions & modification of the present invention without departing from the spirit of this invention.

Abstract

Present Invention is a perfectly reversible technique of compression. The logical transform ensures a loss less and on the fly decompression. The original data/image is retrieved perfectly loss less. As the reversion algorithm of Present Invention is also an integer-to-integer transformation, loss of data is eliminated. The retrieved image is visually and mathematically identical to the original image data.

If the decompressed image is not the same as the original image, it is a lossy compression. Once information is discarded, it can never be retrieved, so when data that has been compressed in this fashion is decompressed, the result is only an approximate

The Wavelet compression algorithm filters the original image into high and low frequency sub-band progressively leading to floating point values that create a loss during the reconstruction process. Also, for a loss less wavelet compression, more number of coefficients is required for the reconstruction, which leads to a low compression ratio.

Present Invention, maintains full fidelity of the original digital data during the process of compression and decompression in a perfectly loss less manner rendering a high compression ratio.

The need of this type of algorithm is particularly known in digital image fields. The Present Invention codification technique is ideally suited for highly correlated

data and digital images, as there is high accuracy requisition and that certain errors and distortions can affect the image quality.

As Present Invention decompression is an exact reverse of the compression process, there is no addition or deletion of data or bits. Also the integer base is maintained through out the compression and decompression giving no room to loss of data. The decompression is also on the fly, exactly same as the compression process.